

Wednesday 07 Feb 2024 – Afternoon

A Level Computer Science

H446/02 Algorithms and programming

Time allowed: 2 hours 30 minutes



You can use:

- a ruler (cm/mm)
- an HB pencil

Do not use:

- a calculator



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.

INFORMATION

- The total mark for this paper is **140**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document consists of **28** pages.

ADVICE

- Read each question carefully before you start your answer.

Section A

Answer **all** the questions.

1 Taylor is creating an online multiplayer game where users can create accounts and build their own circus. Each circus will contain characters such as clowns, animals, magicians and dancers.

Users can set up a new circus in the online world, purchase new characters and visit other users' circuses.

(a) Taylor uses computational methods to analyse the problem including abstraction.

Describe how Taylor could use abstraction in the design of his online circus game.

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[3]

(b) Taylor will make use of concurrent processing within his circus game.

(i) Describe what is meant by the term 'concurrent processing'.

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[2]

(ii) Explain why concurrent processing is needed to allow multiple users to log in and interact with game elements at the same time.

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[3]

(c) Some of the characters in the game will move and interact independently. Taylor is going to use graphs to plan the movements that each character can take within the game.

DancerGold is one character. The graph shown in **Fig. 1** shows the possible movements that DancerGold can make.

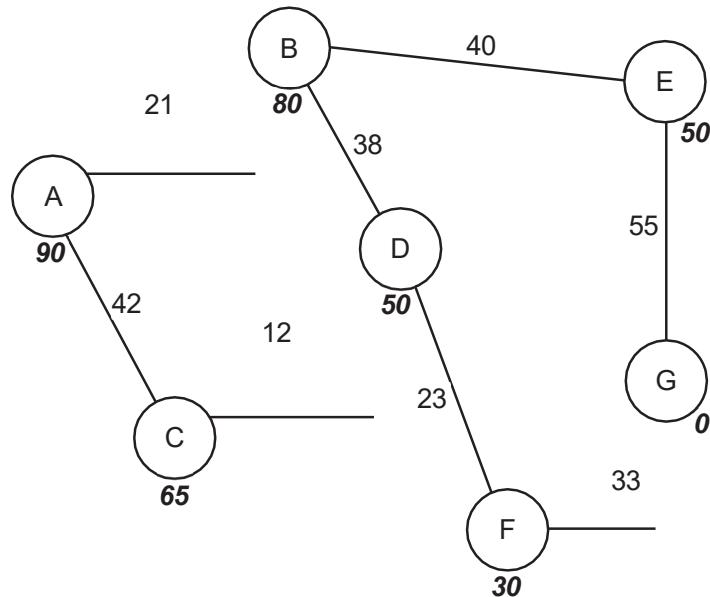


Fig. 1

DancerGold's starting state is represented by node A. DancerGold can take any of the paths to reach the end state represented by node G.

The number on each path represents the number of seconds each movement takes.

The number in bold below each node is the heuristic value from A.

(i) Define the term heuristic in relation to the A* algorithm.

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[2]

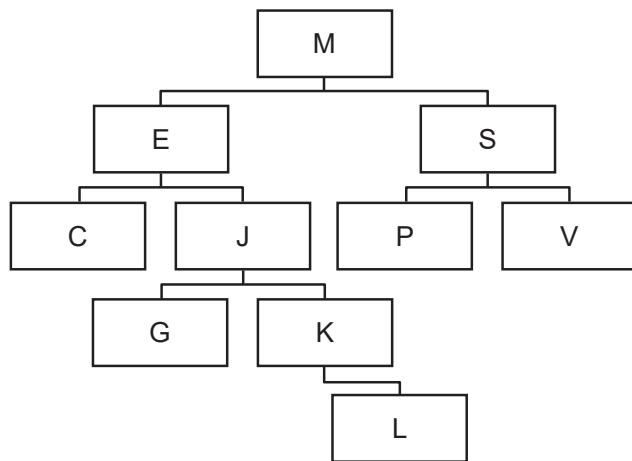
(ii) Perform an A* algorithm on the graph shown in **Fig. 1** to find the shortest path from the starting node to the end node. Show your working, the nodes visited and the distance. You may choose to use the table below to give your answer.

Final path:

Distance:

(d) A breadth-first traversal can be performed on both a tree and a graph.

Show how a breadth-first traversal is performed on the following binary tree.



[6]

(e)* The game will have thousands of users. Taylor will store data about the users and their actions while playing the game in a large database.

Evaluate how Taylor can use data mining to inform future changes to improve his circus game.

3 (a) A one dimensional array holds data that needs to be sorted.

Describe how a quicksort would sort data into ascending order.

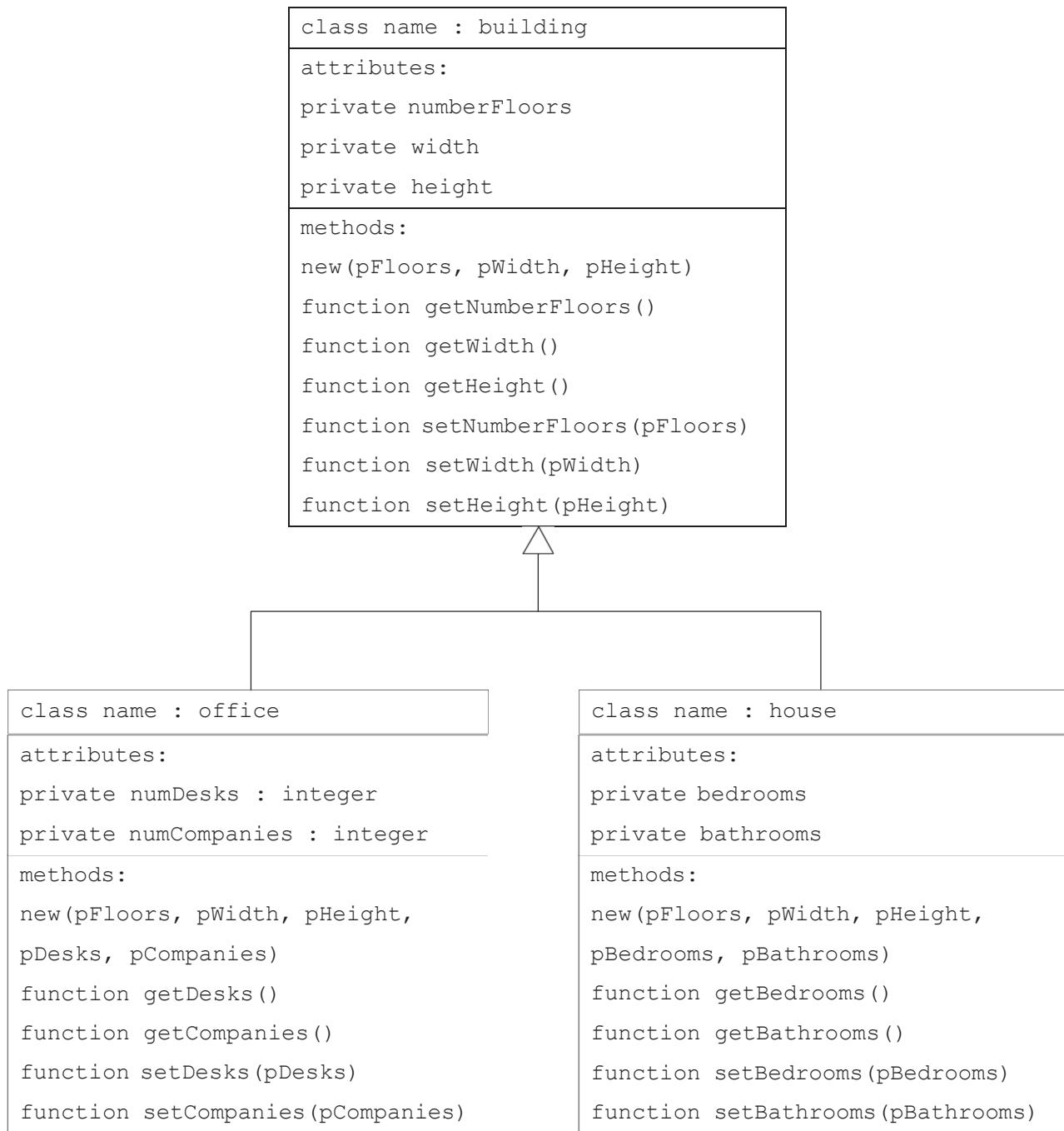
. [5]

(b) Explain why a quicksort is known as a divide and conquer algorithm.

[2]

. [2]

5 Christoff is writing a program to simulate a city using object-oriented programming. He is designing classes to store different types of buildings and their location on the road. He has created the following plan for some of the buildings:



(a) The method `new` is used to denote the constructor for each class.

State the purpose of the constructor.

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[1]

The classes `office` and `house` inherit from `building`.

(b) Describe what is meant by inheritance with reference to these classes.

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[2]

(c) Part of the declaration for the class `building` is shown.

Complete the pseudocode declaration by filling in the missing statements.

```
class building
    private numberFloors
    private width
    private .....
    public procedure new(pFloors, pWidth, pHeight)
        numberFloors = .....
        width = pWidth
        height = pHeight
    endprocedure
    public function getNumberFloors()
        return .....
    endfunction
    public function setNumberFloors(pFloors)
        //sets the value of numberFloors when the parameter is >= 1
        //returns true if numberFloors is successfully changed,
        //returns false otherwise
        if pFloors >= 1 then
            numberFloors = .....
            return true
        else
            return .....
        endif
    endfunction
endclass
```

[5]

(d) Write program code or pseudocode to declare the class house.

Define the attributes and constructor method in your answer. You do **not** need to write the get or set methods.

- [6]

(e) Christoff develops a new class to store the houses in one road. His class design is shown:

class : houseRoad
attributes:
private buildings(100) //array of class house
private numberBuildings //records the number
//of houses currently stored in the array
//buildings
methods:
new(building)
function getBuilding(buildingNum)
procedure newbuilding(pBuilding)

The method `newbuilding()` takes a new building as a parameter, and stores this in the next free space in the array `buildings`.

Write pseudocode or program code for the method `newbuilding()`.

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[4]

(f) Christoff wants to create a new house called `houseOne`. It has the properties: 2 floors, 8(m) width, 10(m) height, 3 bedrooms and 2 bathrooms.

The house is located on a road with the identifier limeAvenue of type houseRoad, houseOne is the first house in this road.

Write pseudocode or program code to declare the house `houseOne`, `road limeAvenue` and assign `houseOne` to the first array position in the `road`.

. [4]

7 Lucas writes a program that makes use of a circular queue. The queue stores the data entered into the program. An array is used to represent the queue.

(a) The program needs two pointers to access and manipulate the data in the queue.

State the purpose of the two pointers and give an appropriate identifier for each.

Pointer 1 purpose

Pointer 1 identifier

Pointer 2 purpose

Pointer 2 identifier

[4]

(b) Lucas wants a procedure, `enqueue()`, that will add the parameter it is passed to the queue.

Describe the steps the procedure `enqueue()` will follow when adding new items to the queue.

[5]